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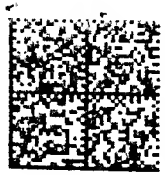

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
09/985,880	11/06/2001	Andrew Hamilton	003636.0131	4508

7590 02/02/2010

ASHOK K. MANNAVA
281 MURTHA STREET
ALEXANDRIA, VA 22304

EXAMINER	
VO, TED T	

ART UNIT	PAPER NUMBER
2191	

MAIL DATE	DELIVERY MODE
02/02/2010	PAPER

Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Office Action Summary	Application No.	Applicant(s)	
	09/985,880	HAMILTON ET AL.	
	Examiner	Art Unit	
	TED T. VO	2191	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *24 January 2008*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-36* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☒ Claim(s) *4-12,16-24 and 28-36* is/are allowed.

6)☒ Claim(s) *1-3,13-15 and 25-27* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *06 November 2001* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☒ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date *01/10/08, 01/24/08, 01/24/08*.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

DETAILED ACTION

1. This action is in response to the amendment filed on 01/24/2008.

Claims 1, 13, 15, 25, 27 are amended.

Claims 1-36 remain pending in the application.

Terms' definition

2. The known terms are listed in the action to support implicit use in the prior arts.

runtime engine

Computer Desktop Encyclopedia: runtime engine

Software that certain applications depend on to run in the computer. The runtime engine must be running in the computer in order for the application to execute. It provides common routines and functions that the applications require, and it typically converts the program, which is in an interim, intermediate language, into machine language.

One might call an operating system a runtime engine because it is always required. Indeed, it "is" the essential runtime engine. However, an operating system is not classified as a runtime engine, but it would fall into the "runtime environment" category (see runtime environment).

Runtime Examples

Java programs require the Java Virtual Machine runtime engine in order to run (see Java). The same goes for Visual Basic programs, which cannot be executed natively in the computer. They need the runtime module that converts the Visual Basic code into the machine language of the computer. In a Windows PC, the actual VB runtime module is named VBRUNxxx.DLL, where xxx is the version number (300, 400, 500, etc.).

Response to Amendment

3. Applicants' amendment and arguments have been fully considered.

It should be noted that claims 1, 3, 13, 15, 25, and 27 show merely "execution". For example, in claim 1:

"*executing said at least one application program by said run-time engine in said handheld mobile wireless client device to create screen definitions from said non-compiled screen definitions with said at least one application program at run-time as if said screen definitions had been defined at compile time*".

It should be noted that the term "said at least", is repeated in many places in the claims; it does not know how many applications in the execution and does not know which application is executed.

It should be noted that the claimed recitation is intended to *handheld mobile wireless client device*; however, a standard compute device like a computer is also *handheld mobile wireless client device.* For example, a laptop computer has the same functionality of a standard computer, and it is a handheld device.

In general, even though the claims intended to a certain compute device, it has no further recitations be different with a standard computer running by standard windows. Thus, the claims are implicitly anticipated by an operation in a computer connected via a network implementing a standard Windows or using a standard browser. The type of the operation is known before the

filing date of this application. Such an operation is PALM OS, Windows CE, Windows 95, or Windows NT etc.

It should be note that Windows/browser can do the same as the execution of the claims. The windows CE is known as a runtime engine (by terms' definition) for pocketPC, Windows Mobiles, smartphone, and many types of handheld devices. It allows files, applications to register and to execute.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

5. Claims 1-2, 13-15, 25-27 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1, 13, 15, 25 and 27 are unclear. For example, within the limitations of claim 1:

"*receiving at least one application program in a handheld mobile wireless client device, said at least one application program comprising compiled program scripts and non-compiled screen definitions;*

activating said at least one application program in said handheld mobile wireless client device;

instantiating [[a]] said run-time engine in said handheld mobile wireless client device; and

executing said at least one application program by said run-time engine in said handheld mobile wireless client device to create screen definitions from said non-compiled screen definitions with said at least one application program at run-time as if said screen definitions had been defined at compile time.",

the functionality of the claim is unclear. The claim's logic is full of contradiction.

Analysis: The claim recites "receiving at least one application program". Thus, assume that it has received one application program. It recites: said [at least one] application program comprises: *program scripts and non-compiled screen definitions*. This shows a contradiction for the term "one application program".

Now, assume that the number of application programs received at the handheld device is greater than one. In the follows phase of the claim, it further recites executing said at least one application program. At this point, there is confusion and contradiction because at least one means it might execute only one (contradicted to the assumption of more than one).

Using **a sequence** of "said at least one..." does not make the claim sufficient antecedent basis; but ambiguously points out the claim subject maters.

Applicant should use only "receiving an application program" and "said application". Since the use one application, the added limitation *program scripts (3) and non-compiled screen definitions* should be amended so that they are part of "one application program".

For these reason, examiner submits that in the current claim, the terms "application program", "at least one application program", "said at least one application program" are all unclear.

Claims 2, 14, and 26 are indefinite because they are dependent on the indefinite Claims.

Claim Rejections - 35 USC § 102

6. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

7. Claim 3 is rejected under 35 U.S.C. 102(b) as being anticipated by Microsoft Corporation (hereinafter: Microsoft) "Microsoft Windows CE Toolkit for Visual Basic 6.0 Guided Tour", MSDN Library, 7-1999.

As per Claim 3: Microsoft discloses,

3. (previously presented) A method for executing application programs, comprising:

receiving at least one application program in a client device;
(Windows CE is installed and run in a handheld client device. For example, see Figure 5, shows

an application name "Project1" created by Visual basic and run in a Handheld PC Pro as a default Device);

activating said at least one application program;
See "Project1"; User who creates the "Project1" can rename this application properly (e.g. "NorthwindCustomerInformatiuon"). See Figure 14, a toolkit that provides an application is registered in the file system of a "client device" such as Handheld PC Pro, so that when the "project1" can be carried under this toolkit. See page 4, "Starting the Windows CE project");

instantiating a run-time engine;
See Figure 14, it includes "run", "debug", i.e. "project1" (of Figure 5) can be run or debug by a run-time engine of the Handheld PC Pro)

executing said at least one application program by said run-time engine;

registering a process identification corresponding to said activated said at least one application program; and

executing a GO method by said run-time engine.

(See Figure 14, it provides a run engine "run" or "debug" as in the manner of compilation when a "new project" completely coded; moreover, the Toolkit included with "Setting the Project Properties" (See page 4) provides screen definition setting).

8. Claims 1, 13, 15, 25, and 27 are rejected under 35 U.S.C. 102(a) as being anticipated by Bonifati et al., "Building Multi-device, Content-Centric Applications Using WebML and the W3I3 Tool Suite", 1-2000, Springer-Verlag, pages 64-75.

As per Claim 1: (currently amended) ***A method for executing application programs, comprising:***
receiving at least one application program in a handheld mobile wireless client device, said at least one application program comprising compiled program scripts and non-compiled screen definitions;

(A tool in a server side that builds mobile application (see p. 68: i.e. application coded in WebML), this application is received by a mobile device (See p. 70: sec 4, i.e. WAP-enable mobile phone); the mobile application includes pages and style sheets, which are "sever-side scripting language" such as ASP or JSP (see p. 68: sec. 3, p. 69, sec. 3.2: i.e. *compiled program scripts* and *non-compiled screen definitions;* or see p. 66: style sheet/DTD)

activating said at least one application program in said handheld mobile wireless client device;

See p. 73, Fig 6 and its description text in the last three lines

instantiating [[a]] said run-time engine in said handheld mobile wireless client device; and
(Note a screen of a mobile phone shown in Fig. 6 is a runtime engine. See p. 66, sec. 2.3: instance is displayed on mobile phone screen)

executing said at least one application program by said run-time engine in said handheld mobile wireless client device to create screen definitions from said non-compiled screen definitions with said at least one application program at run-time as if said screen definitions had been defined at compile time.
See p. 73: Fig. 6 is result of a running application from the screen interface/template generation via Hypertext Model.

As per Claims 13, 15, 25, and 27: Claims 13, 15, 25 and 27 have the limitation corresponding to functionality performed by the method of Claim 1. The claims are rejected in the same reason set forth in connecting to the rejection of Claim 1.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> A person shall be entitled to a patent unless –
>
> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 2, 14, and 26 are rejected under 35 U.S.C. 103(a) as being unpatentable over Bonifati et al., "Building Multi-device, Content-Centric Applications Using WebML and the W3I3 Tool Suite", in view of Microsoft.com (hereinafter: Microsoft-2), "The Windows® CE SDK- The Tools You Need to Program the Handheld PC", Microsoft Systems Journal, 4-1997.

As per Claim 2:

-Bonifati does not disclose the limitation recited in Claim 2. However, Bonifati suggests its Engine is web supported, interacted with a server-side that produces HTML pages, web sites, on the mobile phone.

-Microsoft discloses (a handheld device using Windows CE that is able to register an application via a registry edit (See Microsoft-2, p. 7-8, Figure 5)) "***registering said at least one application program with an operating system of said client device; and displaying an icon configured to represent said at least one application program in response to said registration***".

-Therefore, it would be obvious to ordinary in the art to incorporate the registry system as Microsoft into the disclosure of Bonifati as for conforming to an execution requirement of operating system standardized in any computing device; thus, it allows the device to know the application.

As per Claims 14 and 26: Claims 14 and 26 have the limitation corresponding to functionality performed by the method of Claim 2. The claims are rejected in the same reason set forth in connecting to the rejection of Claim 2.

Allowable Subject Matter

11. Allowable subject matter of Claims 4-12, 16-24 and 28-36

Claims 4-12,16-24 and 28-36 are allowed because the independent Claims of these Claims are rewritten in independent form including all of the limitations of the base claim and any intervening claims in accordance to Allowable subject matter in the prior action.

Conclusion

12. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Ted T. Vo whose telephone number is (571) 272-3706. The examiner can normally be reached on 8:00AM to 4:30PM.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wei Y. Zhen can be reached on (571) 272-3708.

The facsimile number for the organization where this application or proceeding is assigned is the Central Facsimile number **571-273-8300**.

Any inquiry of a general nature or relating to the status of this application should be directed to the TC 2100 Group receptionist: 571-272-2100. Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

TTV
January 30, 2010

/Ted T. Vo/
Primary Examiner, Art Unit 2191

FORM PTO-1449 To: U.S. Department of Commerce

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Atty.	M#	Client Ref.
Bollman	20-555	20-555

Applicant: HAMILTON
Appln. No.: 09/985,880
Filing Date: November 6, 2001
Examiner: vo | Group Art Unit: 2191

Date: January 10, 2008 Page 1 of 2

U.S. PATENT DOCUMENTS

Examiner's Initials*		Document Number	Date MM/YYYY	Name (Family Name of First Inventor)	Class	SubClass	Filing Date (if appropriate)
	AR	5684990					
	BR	5857201					
	CR	5867688					
	DR	5974238					
	ER	6000000					
	FR	6003040					
	GR	6044381					
	HR	6247135					
	IR	6324544					
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Examiner /Ted Vo/ (01/30/2010) Date Considered: 01/30/2010

*EXAMINER: Initial if citation considered, whether or not citation is in conformance with MPEP § 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to Applicant.

ALL REFERENCES CONSIDERED EXCEPT WHERE LINED THROUGH. /T.V./

FORM PTO-1449 Receipt date: 01/10/2008 To: U.S. Department of Commerce

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U.S. PATENT DOCUMENTS

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FORM PTO-1449 *o: U.S. Department of Commerce

Receipt date: 01/24/2008

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Atty. Bollman	M# 2. .5	Client Ref. 20-555	
Applicant: HAMILTON			
Appln. No.: 09/985,880			
Filing Date: November 6, 2001			
Examiner: vo		Group Art Unit: 2191	

JAN 24 2008 PATENT & TRADEMARK OFFICE

Date: January 10, 2008 Page 1 of 2

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INFORMATION DISCLOSURE STATEMENT BY APPLICANT

Date: January 10, 2008 Page 2 of 2

Atty.	MH
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OIPE JAN 24 2008 PATENT & TRADEMARK OFFICE

Applicant: HAMILTON

Appln. No.: 09/985,880

Filing Date: November 6, 2001

Date: January 25, 2008 Page 1 of 4

Examiner: vo Group Art Unit: 2191

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Examiner's Initials*		Document Number	Date MM/YYYY	Name (Family Name of First Inventor)	Class	SubClass	Filing Date (if appropriate)
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	BR	5,845,293	12/1998	Veghte			
	CR	5,884,323	3/1999	Hawkins			
	DR	6,034,621	3/2000	Kaufman			
	ER	6,205,448	3/2001	Kruglikov			
	FR	6,487,560	11/2002	La Rue			
	GR	2003/0069874	4/2003	Hertzog			
	HR	6,560,655	5/2003	Grambihler			
	IR	6,701,521	3/2004	McLlroy			
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	Examiner TED T. VO	Art Unit 2191	Page 1 of 1

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Building Multi-device, Content-Centric Applications Using WebML and the W3I3 Tool Suite

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Abstract. In the forthcoming years, two factors will jeopardize the deployment of Web applications: supporting multi-device outputs and one-to-one personalization. These two factors will lead to an explosion of solutions, to be developed, maintained, and kept consistent; meanwhile, Web hosting companies will be subject to growing service demands and will be lacking the technical man-power required to master them. With these premises, the strength of the W3I3[1] tool suite is to propose a model-driven approach to Web site design. Such an approach is based on WebML, a high-level language for specifying the structure of the content of a Web application and the organization and presentation of such a content in a Web site. In this paper, after a brief presentation of WebML, we concentrate on the W3I3 tool architecture, shown at work on case-study based on the popular site http://www.softseek.com.

1 Introduction

Designing data-intensive Web sites, i.e. sites whose primary purpose is the publishing of large volumes of data, is a primary concern for many companies. This challenge is going to become more demanding in the close future, because the activity of designing, deploying and evolving sites will face the need of serving content simultaneously to a variety of individuals or user groups, possibly equipped with different devices, each one characterized by specific rendition capabilities. In particular, WAP-compliant cellular phones, featuring WML-enabled microbrowsers [14], are already spreading in the market.
The W3I3 tool suite addresses personalized and multi-device content deployment by leveraging three different aspects of its architecture:

1. The possibility of organizing content at a high-level, using the WebML conceptual site modeling language ([5], http://webml.org). Alternative forms of content composition can be expressed as **site views**, and each site view

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may cluster information and services at the granularity most suitable to a particular class of users and devices.
2. The availability of an abstract presentation language, by which it is possible to construct reusable page descriptions (called **style sheets**) independent of the specific markup language required by the user's device. Style sheets specify pages in terms of content elements arranged in a nested grid model. They are written in XML [15].
3. The XSL-enabled translation technology [16,17], which maps abstract XML page specifications into concrete code in the languages of choice. The choice of language regards both the presentation, in which a specific markup language is selected (e.g., WML), and the binding of data to pages, where alternative server-side scripting languages can be used (e.g, Microsoft's Active Server Pages).

In this paper, after a brief presentation of WebML, we focus on the W3I3 tool suite architecture and on its individual components; we next show the tools at work in the modeling of an existing Web site (http://www.softseek.com).

2 The WebML Site Specification Language

WebML [5] is a high-level specification language allowing designers to express the core features of a site and abstracting them from architectural details. WebML concepts are represented in an intuitive graphic fashion, which can be easily supported by CASE tools and is conceived for non-technical members of the site development team (e.g., graphic designers and content producers). WebML internally relies on an XML syntax, which can be fed into software generators for automatically producing the implementation of a Web site. The specification of a site in WebML addresses four orthogonal perspectives: the structural model, the hypertext model, the presentation model, and the personalization model.

2.1 Structural Model

WebML does not propose yet another language for data modelling, but is compatible with classical notations like the E/R model [6], the ODMG object-oriented model [4], and UML class diagrams [3]. The fundamental elements of the WebML structural model are *entities* - acting as containers of data elements - and *relationships* - enabling the semantic association between entities. Entities have named properties, called *attributes*, with an associated type; properties with multiple occurrences can be represented by means of *multi-valued components*, which express a part-of relationship. Additional classical ingredients of conceptual models are present in WebML: *generalization hierarchies* for entities and *cardinality constraints* for relationships. An example of structural model for the SoftSeek case study is described in Section 4 and shown in Figure 2.

2.2 Hypertext Model

The hypertext model includes suitable constructs for representing one or more hypertexts, which can be published on top of the information described by the structure model. Each different hypertext defines a so-called site view; **site view** descriptions in turn consist of two sub-models, which are respectively called **composition** and **navigation** models.The composition model specifies which pages form the hypertext, and which content units (the atomic information elements that may appear in the Web site) make up a page. WebML content units are: data, multi-data, index, filter, scroller and direct units. Data units are used to publish the information of a single object (e.g., a software item), whereas the remaining types of units represent alternative ways to browse a set of objects (e.g., by presenting a subset of them in the same page, or by presenting an index, a search filter, first/last/previous/next scrolling commands, or finally by giving a direct access to a specific single element). Composition units are mapped to entities or relationships of the structural schema, from which they draw their content. The navigation model expresses how pages and content units are linked to form a hypertext. Links are either non-contextual, when they connect semantically independent pages (e.g., the page of an article to the home page of the site), or contextual, when the content of the destination unit of the link depends on the content of the source unit (e.g., the list of download sites associated to a given software item). Contextual links conform to the structure schema, because they connect content units whose underlying entities are associated by relationships in the structure schema. Examples of hypertext model for the SoftSeek case study are shown in Figure 3 and 4.

2.3 WebML Presentation Languages

Presentation is the modeling perspective concerned with the appearance of pages on the screen. WebML specifies presentation at the conceptual level, i.e., independently of the particular instance to be presented and on the specific rendition language. The basic unit of presentation is the **page**, as defined in composition modeling. Each page is associated to one or more **style sheets**, each specifying a different way of presenting its instances on the screen. Style sheets are XML documents obeying the WebML presentation DTD, which can be defined visually by means of a tool called Presentation Designer. The WebML presentation DTD includes tags for layout and content modeling.

The layout of each style sheet is a bi-dimensional rectangular space (represented by element space2d shown in Figure 1), which may include a set of possibly overlapping regions. Each region can be organized into a grid having an arbitrary number of rows and columns; each cell of the grid can recursively contain other regions, which can in turn be organized as nested grids. Cells of a grid are defined as the intersection of row and column ranges; therefore they may correspond to macro-cells made of several elementary cells forming a rectangular area. After layout definition, the next step in style sheet definition is to specify which piece

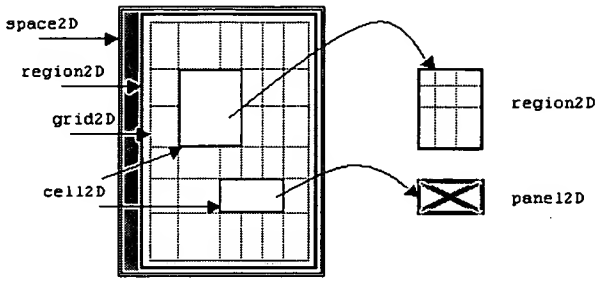

Fig. 1. Main XML elements pf WebML presentation DTD

of content goes into the various regions placed at the bottom of the hierarchical structure of the page (typically those contained in the cells of some grid). Content elements are specified using panels, i.e. XML fragments specifying an atomic or composite content element (e.g., a piece of text), which can be inserted into a region.
An example of page presentation applied to the running case of the SoftSeek site is detailed in Section 4 and shown in Figure 5.
Various rendition languages (HTML 3.2, HTML 4, WML, etc.) can be used to concretely implement the abstract presentation of pages. WebML presentation model can be extended to represent the peculiar aspects of a rendition language by including additional language-specific properties or constraints, which affect layout elements and panel templates. These extensions are again expressed in XML and collected in a document called *language profile*. For instance, a "background image" property for such layout elements as grids and cells is part of the language profile for HTML, but is not available in the profile for WML.

2.4 Personalization Model

Users and user groups are explicitly modelled in the structure schema in the form of predefined entities called User and Group (automatically provided by the site design tools, once a new project is created). The features of these entities can be used for storing group-specific or individual content, like shopping suggestions, list of favourites, and resources for graphic customisation, which can be published in a site view as normal content. In addition, OQL-like declarative expressions can be added to the structure schema, to define derived content based on the profile data stored in the User and Group entities, e.g., a discounted price based on the user's shopping history. Moreover, business rules can be generated in order to change the site's content according to user-specific information or to compute user profile data.

3 A Tool Architecture for Personalised, Multi-device Application Generation

WebML conceptual modelling is backed by a software architecture, which supports all the steps necessary to transform the WebML specification of a site into a running application in spectrum of industrial-strength rendition languages and server-side application platforms. The architecture of the WebML tool suite consists of three software layers: (a) the design tools, used for collecting design specifications (b) the device-specific template generators (c) the platform-specific adapters.

- The **design tools** support the modeling of Web applications at the conceptual level; the output of the design layer is a **conceptual schema** of the application, coded in WebML.
- The **code generation** layer transforms the conceptual schema of the application into an intermediate representation suitable for processing on top of commercial Web-database systems. This intermediate representation consists of a collection of **page templates**, which embody the structure, navigation, composition, and presentation of the application, but do not include to the actual data. Page templates are bound to a specific delivery language (e.g., HTM 3.2 or WML), and to a specific scripting language to be interpreted at server side (presently, MicroSoft's Active Server Pages, and JavaSoft's Java Server Pages).
- The **run-time adapters** consists of a set of lightweight Java components installed at the server-side, which give access to the actual data structures, which host the content of the entities and relationships defined at design time. This software layer shields the generated templates from the query language needed to bind the actual data to page when serving user requests. Presently W3I3 includes runtime adapters for wrapping JDBC compliant relational DBMSs and LDAP repositories.

3.1 Design Environment

The Design Environment includes three tools:

- **Site Designer**: permits the designer to define the structural model and the hypertext model of the application. Complex functions like the specification of derived data or the creation of an initial default site view are simplified by wizards, which, for instance, allow users to write OQL-like queries for expressing derived data in a visual way.the tool implements an advanced functions for user support, which perform the syntactic and semantic check of the project graph; if mistakes are detected, warning messages and tips are automatically presented to the user, which explain what is wrong and how to fix the problems
- **Presentation Designer**: deals with the specific aspect of presentation specification.The designer may define both generic and page-specific layouts. A

generic style sheet (also called presentation model, or untyped style sheet) is a specification of a page in terms of layout and fixed content elements (e.g., logos, fixed texts or images), which are independent of the specific objects used to fill the page. A **page-specific style sheet** (also called typed style sheet), instead, describes a page layout at a more detailed level, mentioning the actual elements (data fields, outgoing links, indexes, search forms, and so on) included in a certain page. Presentation Designer includes the support of multiple languages also.

- **Site Manager**: supplies all the required functions for publishing a W3I3 site on top of the runtime layer and data sources, and for maintaining it. These features are **site creation**,which invokes the Template Generator (see below) which builds the page templates necessary to run the application. the **site publishing** function is used to move all the application resources to the deployment server. The **user management** function addresses the specification of the access rights. Finally, Site Manager includes a **mapping function** for declaring the association between the structural model concepts and the repository structures chosen for the storage of data

The above tools are integrated by means of a further component, called **Repository Manager**, which manages the communications with all clients co-ordinate their access to the Central Design Repository, which hosts the WebML specifications in the form of XML documents and the graphic resources used in style sheets.

3.2 Template Generation

The Template Generator transforms a style sheet into a give rendition language (presently, HTML3.2 and WML are supported). The first use of the Template Generator is at design time to obtain a preview of the style sheet under construction. A **preview function** (launched from Presentation Designer) processes the XML specification of the style sheets, fetches the page characteristics from the design repository, and outputs a static file in the markup language of choice, in which the data content of the page is mocked-up (e.g., the value of attributes of type image are replaced by a reference to a constant image file). The second use of the Template Generator is at publication time, when the pages and style sheets of the site are transformed into ASP or JSP templates including instructions in a server-side scripting language for accessing the real data from the runtime data sources.
The Template Generator implements a multi-step process for transforming a WebML style sheet into a page template in a specific mark-up and server-side scripting language pair. The translation proceeds according to the following steps:

1. **Unfolding**: the original style sheet may contain composite panels and references to sub-pages, whose layout is described in a separate style sheet. The unfolding phase fetches all the necessary panel template and style sheets

definitions, and recursively replaces composite panels and sub-pages with their layout specification. The result is an unfolded style sheet equivalent to the original one but consisting only of atomic panels (images, texts, and anchors).
2. **Layout annotation** and optimisation: the unfolded style sheet is traversed to compute auxiliary information (e.g., the coordinates of the starting and ending point of all cells) and to apply optimisation operators to the unfolded layout (e.g., the removal of unnecessary nesting levels introduced by the procedure for recursive unfolding). At this stage, the process is still independent of the mark-up and server side scripting language.
3. **Data reference** translation: abstract data references contained in panels are converted from the WebML syntax to the syntax of the chosen server-side scripting language (e.g., Visual Basic Script). At this stage, the partially translated style sheet is bound to a specific server side platform.
4. **Mark-up translation**: the partially translated style sheet is fed to an XSL processor, which applies to it a set of rules, contained in an XSL file designed for the specific output mark-up language. The XSL file includes templates for mapping the WebML abstract layout tags into the most suitable constructs of the chosen rendition language. The output of mark-up translation is the final template, ready to be installed in the deployment server.

The core benefit of the described architecture is flexibility: a new rendition language can be easily added without changing the implementation. All the language dependent features are expressed in an XML-based syntax and the only tasks to be performed for integrating new languages are the creation of a new language profile (which requires the editing on an XML file), the creation or extension of panel templates to introduce language-specific properties (XML-based too) and the addition of an XSL file giving the rules for the mark-up conversion.

4 The SoftSeek Case-Study

As an example of WebML-driven site design, we now show how the popular SoftSeek Web Site (http://www.softseek.com) can be modelled using the WebML tools, and re-engineered to obtain a version of the same content accessible via a WAP-enabled mobile phone. The SoftSeek Web Site allows searching, downloading and accessing documentation about software products. The software items are classified into several groups (editor's picks, top downloads, spotlight products, new releases, and so on) and are clustered in categories; each category has a name and a brief textual description, and can contain further sub- and sub-sub-categories. Categories and subcategories relate to spotlight and top products, whereas the sub-sub-categories include the complete listing of all products featured in that sub-sub-category. Each product is characterized by a set of technical data (e.g., version, size, release date, sample screenshot, descriptive text etc..), and is connected to the product's supplier, to related products from the same author, and to a set of download sites. Figure 2 shows the information published in the SoftSeek site represented as entities (categories, software items,

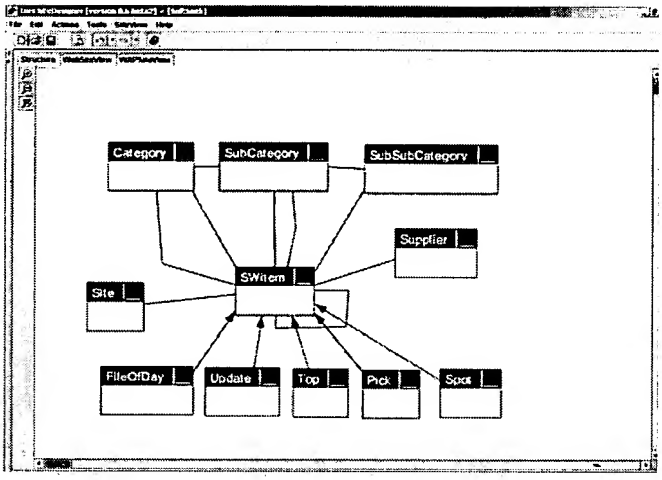

Fig. 2. Structural model of the case study edited with Site Designer

suppliers, download sites) and relationships (categories to subcategories, software items to download sites, suppliers and software items of the same supplier). An inheritance hierarchy represents classification of special software items.

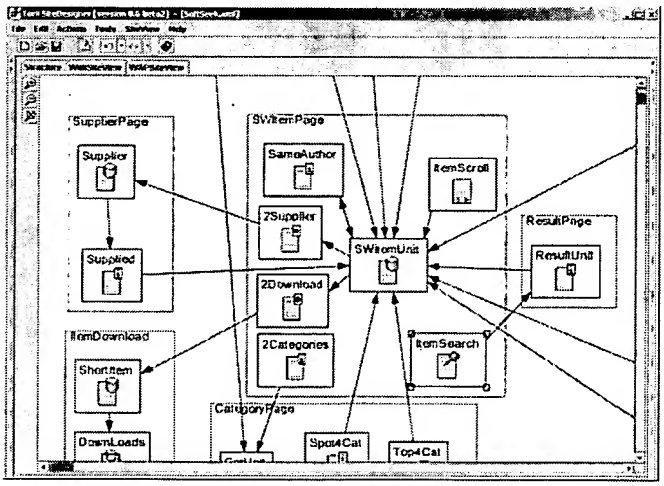

Fig. 3. An excerpt from the SoftSeek Web site view modeled in Site Designer

After consolidating the structural model, the hypertext model is designed: a different site view must be defined for the different devices,to cluster information differently based on the capability of each medium. Figure 3 shows a portion of the site view for the web version of the SoftSeek application. Due to space limitation,

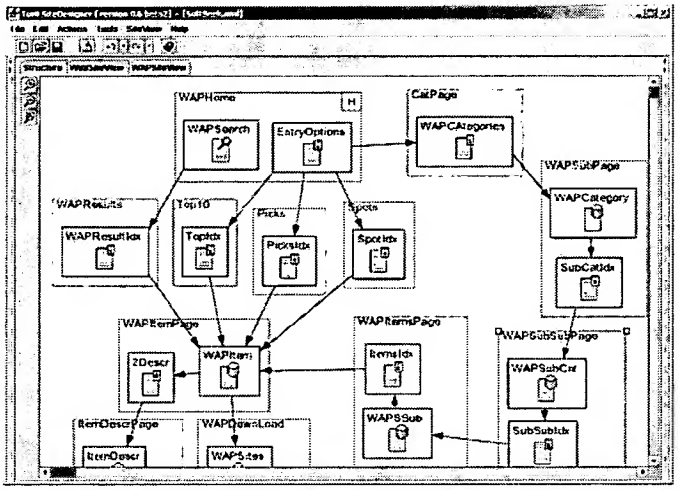

Fig. 4. Example of WAP site view for the SoftSeek case study

it is impossible to describe the complete schema and thus we concentrate on the design of the most representative pages only. At the top of the site view diagram, page *SWItemPage* describes the core information of a product.

Its center is the *SWItemUnit* data unit, which holds the product data (name, version, size, description text, image, and so on). *SWItemUnit* is linked via two direct units to the single supplier of the product (unit *Supplier* in *SupplierPage*), and to an alternative product page (*ItemDownload*), which includes a short description of the product (data unit *ShortItem*) and the set of sites wherefrom the product's file can be downloaded (multidata unit *Downloads*). *SWItemUnit* is also linked to the index of the other products by the same author (unit *SameAuthor*), from which it is possible to move to the page of another item, and to a scroller unit (*ItemScroll*), which permits the reader to move to the previous and next item in the same sub-sub-category. *SWItemPage* also contains an index of all the top-level categories (the index unit *2Categories*) and a search form (unit *ItemSearch*) to locate a product by keyword.

As an example of the support offered by the W3I3 tool suite to the specification and management of multi-device applications, figure 4 shows a second site view constructed on the same structure model of Figure 2, but aimed at

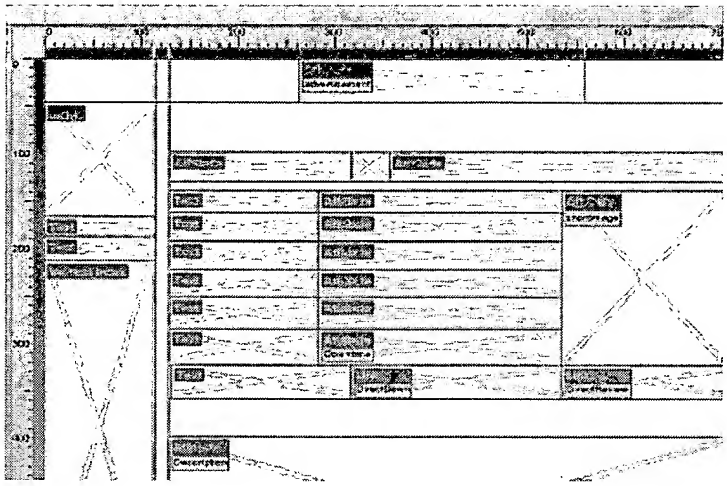

Fig. 5. Style sheet for the SWItemPage constructed in Presentation Designer

WAP devices. The WAP view is characterized by a finer granularity and less navigation options than the Web view, because wireless devices have a smaller display and thus entities must be split on different pages, and only the essential navigation facilities can be effectively used. Finally, we show the last step of application design in W3I3, which requires the use of Presentation Designer to define style sheets for the site view pages. Two sets of style sheets are required, one for PC browsers and one for WAP devices. Figure 5 shows a screenshot from the construction of the layout of the Web *SWItemPage*: different atomic and composite panels embedding the content elements of the page are arranged in a grid-based layout. The page was generated as so to be very similar to

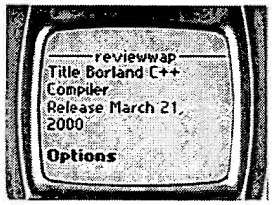

Fig. 6. Output of the WML Template Generator on WAPItemPage

the actual page for showing software items in the softseek application(e.g. see www.softseek.com/Programming/C/Review 32546 index.html). Figure 6 show a wml page, obtained by running the Template Generator on a styel sheet edited

in Presentation Designer using the WML language profile. Both page templates contain mark-up and sever side scripting code generated in a totally automatic way by the W3I3 tools.

5 Related Work

An array of tools is developed by the industry and academia to create and manage data-intensive Web sites. For brevity, we only present a selection of products that leverage some form of model-driven design, while we refer to [9] for a complete survey. **Designer 2000** [10] is a CASE environment included into the Oracle platform for deploying Web application based on a Web-enhanced entity-relationship design. Its Web Generator delivers PL/SQL code, which runs within the Oracle Web Server to produce HTML pages. Designer 2000 adopts a very database-centric approach while the W3I3 architecture adopts a mix of data, hypertext, and presentation modelling. In **Strudel**, a research project developed at AT&T Labs [7], Web sites are created from the declarative specification of the site's structure and content, in the form of queries over a data model for semi-structural information.**Homer** [2] is a CASE tool for building and maintaining data intensive Web site developed by researches of Università di Roma tre. The site schema is described by a formal model called AMD [1], which mixes database and hypertext concepts. Like the W3I3 tool suite, Homer can generate output for HTML and XML/XSL format, but Homer does not address presentation design. In the field of multi-device site development, Oracle's **Portal-To-Go**, [12] is a new server product that enables any existing database and Internet application to be made accessible from WAP phones, PDAs and other mobile devices. Portal-to-Go makes existing Internet or database applications device-independent, by extracting their content, dynamically converting it to XML, and then to the mark-up language supported by the user's device, including WML, TinyHTML, and VoxML. Portal-to-go, unlike W3I3, does not rely on a model-driven approach, and could be used as a runtime layer from the W3I3 tool suite, by adding an XSL translator targeting the Portal-To-Go XML DTD.

6 Conclusions

W3I3 tools have been applied to the modeling of a large number of case studies and applications, both in the context of the user companies of the W3I3 project, and by graduate students of our department. The W3I3 approach guarantees the following advantages:

- Increased productivity of Web developers. The use of a high-level, model-driven approach coupled to fully automatic code generation facilitates the design and thus lowers the technical edge of Web developers, alleviating an essential problem of most Web hosting companies.
- Lower ownership costs. The use of a model-driven approach eases maintenance and evolution, because changes can be analyzed at a higher level and

propagated to the implementation. This feature is essential in view of the exponential growth of complexity of Web sites caused by the interplay of multi-device output and one-to-one delivery.
- Higher consistency across applications delivered to different output devices. We envision Web applications that offer a consistent and stateful interaction to users who, e.g., initially connect from home (e.g., via digital TV), then access the application while traveling (by means of a mobile device), then in the office (via personal computer). Interaction uniformity is guaranteed by W3I3's content-centric design, where information is modeled once and then adapted to different media and deployed automatically.

All the key features of the W3I3 tools are fully implemented, and the final version of the W3I3 tool suite will be available by the end of the W3I3 project (October 2000).

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